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Science Advisory Report 2013/016

ASSESSMENT OF ATLANTIC SURFCLAM IN THE COASTAL WATERS OF THE ÎLES-DE-LA-MADELEINE IN 2012

S. Brulotte, DFO, Québec Region, 2012.

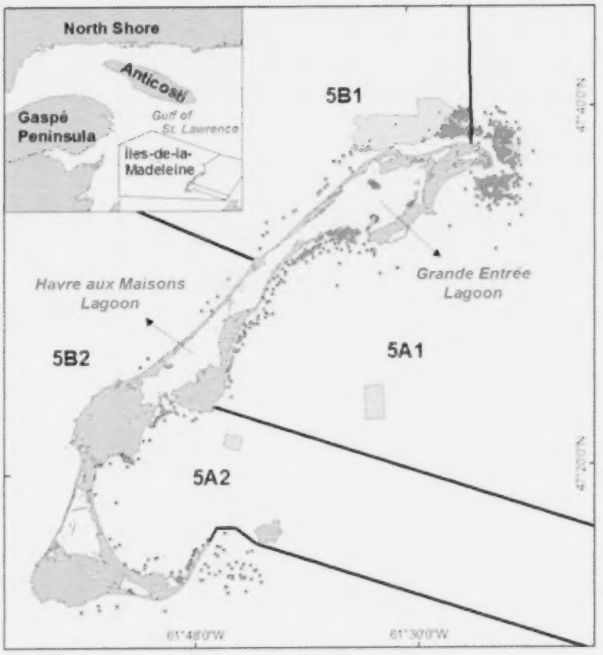

Figure 1. Management sub-areas (5A1, 5A2, 5B1 and 5B2, solid line) and known distribution (red circle) of Atlantic surfclam in the Îles-de-la-Madeleine.

Context:

*In Québec, the Atlantic surfclam (*Spisula solidissima*) fishery is practiced exclusively in the Îles-de-la-Madeleine. The fishery is conducted in two different ways, either by boat with a hydraulic dredge in coastal waters, or manually on foot or while diving in lagoons or near the coast. Fishing Area 5 in the Îles-de-la-Madeleine is divided into four sub-areas, and dredge fishery is primarily conducted in sub-areas 5A1 and 5B1. Hand digging may be recreational or commercial, and is conducted in approximately 10 shellfish sectors.*

Stock assessment of this resource is done every three years. The main indicators used for monitoring stocks are landings, fishing effort, catch per unit effort (CPUE) and size structure.

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SUMMARY

- The Atlantic surfclam fishery in the Îles-de-la-Madeleine is conducted with hydraulic dredges in sub-areas 5A1 and 5B or using hand tools, on foot or while diving, in about 10 shellfish sectors located in lagoons or near coasts.

Hydraulic dredge fishery

- In sub-area 5A1 in 2012, the total allowable catch (TAC) was 125 tons (t) and landings totalled 134 t with a fishing effort of 21 days, which is less than 58% of the average effort during the reference period. In 5B1, the TAC was 100 t in 2012 and landings totalled 103 t with a fishing effort of 20 days.
- CPUE has been increasing in 5A1 since 2008, and reached a record high of 314 kg per hour/meter (kg/hm) in 2012. In 5B1, annual CPUE has been relatively stable since 2009. In 2012, CPUE was 275 kg/hm, which was higher than the reference average.
- Over the past three years, the average size of landed surfclam has been the same or greater than the reference average in sub-areas 5A1 and 5B1.
- The shift in fishing effort to new portions of surfclam beds from one year to another resulted in good yields and stable size structures.
- From 2010 to 2012, the proportion of known beds dredged annually was 3% in 5A1 and 13% in 5B1.
- Given that the fishery indicators were positive in 5A1 and that the proportion of the surface dredged was low, the TAC could be increased to 10% for 2013, as long as the annual fishing effort is limited to 50 days. Although the various indicators were relatively stable in 5B1, a large proportion of beds are dredged every year. As a result, the same TAC is recommended and fishing effort must be limited to 30 days.
- Sub-area 5A2 has not been fished since 2002, and fishing effort has been sporadic and low in sub-area 5B2. It is therefore impossible to comment on the status of the resource in these two sub-areas.

Hand digging

- The available information on hand digging, either on foot or while diving, is limited. This type of harvesting is very popular and well-developed. The average known annual landings from commercial hand digging is about 22 t; however, this value is underestimated and the amount of surfclam harvested recreationally is unknown.
- The available logbooks show that since 2010, the annual CPUE calculated from commercial harvesting on foot or while diving has been under the respective reference averages.
- The area of three hand harvested beds was determined in 2012. These beds are nearly all accessible on foot. The surfclam density of two of these beds, located in the Grande Entrée lagoon, is lower than that observed in 2007, which suggests a high fishing pressure.
- Given this information and the lack of knowledge of the contribution of beds accessible on foot to the recruitment to the Atlantic surfclam population in the Îles-de-la-Madeleine, it is recommended that hand harvesting be limited significantly.

BACKGROUND

The Atlantic surfclam, *Spisula solidissima*, is a filter feeding bivalve mollusc that lives along the Atlantic coast of North America, from Gaspé Bay in the Gulf of St. Lawrence to Cape Hatteras, in North Carolina. The surfclam habitat extends from the upper infralittoral zone to a depth of 30 to 60 m depending on the region. The surfclam lives buried in sediments and prefers mixtures of sand, clay and gravel. It is a sedentary species living in aggregations of more or less importance called "beds".

According to the literature, age at sexual maturity of Atlantic surfclams is four years. The legal catch size of 76 mm is reached in four or five years at the Îles-de-la-Madeleine. The surfclam can live more than 30 years and reach a size of 226 mm. The maximum size observed in the Îles-de-la-Madeleine is 171 mm.

The sexes are separate and there is no sexual dimorphism for the surfclam. In the Îles-de-la-Madeleine, the gonads are fully mature by mid-May. Spawning takes place mainly in July and August. The gametes are released into the water where the fertilization of ovules occurs. The larvae are pelagic. The duration of the larval phase is dependent on water temperature; 35 days at 14°C. After metamorphosis, juveniles settle to the bottom and begin their benthic life stage.

Overall, the recommended conservation measures are to ensure the sustainability of each bed by maintaining reproductive potential.

ASSESSMENT

In the Îles-de-la-Madeleine, the Atlantic surfclam fishery is conducted with a hydraulic dredge in Area 5 or by using hand tools, on foot or while diving in the lagoons or along the coast (Figure 1). The minimum legal size is 76 mm for both types of harvesting. Moreover, the Atlantic surfclam fishery is prohibited in shellfish sector A-08.4 (refuge area) and in exclusion zones, most of which were created to ensure the protection of lobster habitat (Figure 2).

Commercial fishery indicators, or landings (t of live weight), fishing effort (number of days) and CPUE (km/hm for dredging or kg/h for hand digging), are compiled from information taken from logbooks and purchase slips. Size structures and median size is measured from the surfclams landed by the DFO's commercial catch sampling program. The dredge harvesting positions are available from the logbooks from 2002 to 2012 and from sampling at sea conducted by observers since 2005. CPUE have been standardized to reflect the harvesting month and fisherman for dredge harvesting and the shellfish sector for hand digging.

Hydraulic dredge fishery

Exploratory fisheries were conducted in the Îles-de-la-Madeleine in 1978, 1984 and 1985. The area covered at that time did not reveal beds large enough to support a commercial fishery. However, some fisherman continued to explore the territory and discovered Atlantic surfclam beds of interest that could support a commercial hydraulic dredge fishery. A management plan to oversee this commercial fishery was not established until the fall of 2001. Monitoring this fishery became possible only in 2002, with the introduction of logbooks.

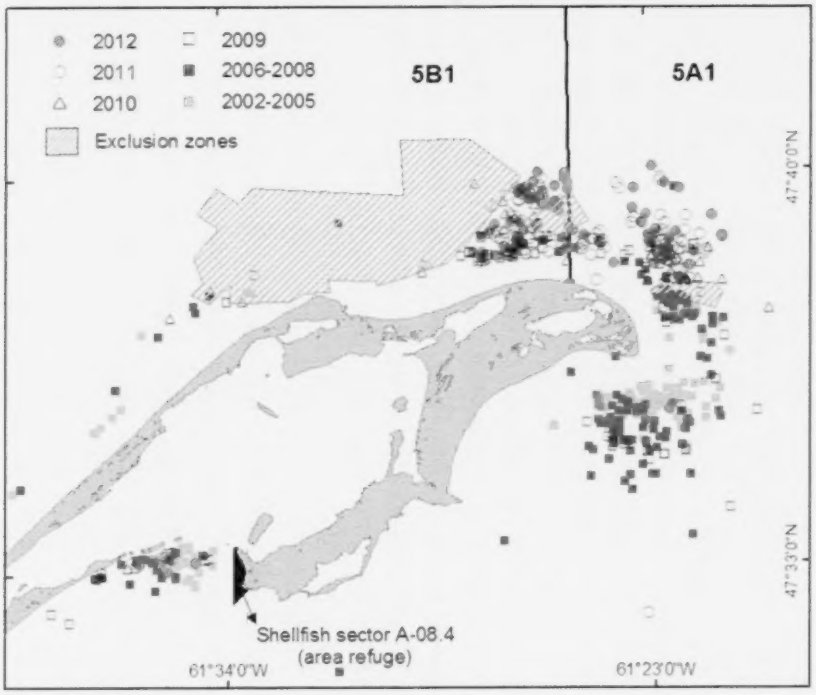

Figure 2. Localized fishing effort of Atlantic surfclam for commercial dredge harvesting from 2002 to 2012 for sub-areas 5A1 and 5B2 in the Îles-de-la-Madeleine, exclusion zones and refuge areas.

In Québec, the commercial Atlantic surfclam dredge fishery is limited to Area 5 of the Îles-de-la-Madeleine. At first, harvesting was concentrated exclusively in the east of the archipelago, in an area circumscribed by current sub-area 5A1. To encourage fishermen to explore all of Area 5, the territory was divided into sub-areas. Four sub-areas have been established since 2011: 5A1, 5A2, 5B1 and 5B2 (Figure 1). Despite these incentives, sub-area 5A2 has not been harvested since 2002. The exploitation rate in sub-area 5B2 is low and it is only harvested sporadically. Stock assessment can therefore only be performed in sub-areas 5A1 and 5B1.

There are four commercial dredge harvesting licenses in the Îles-de-la-Madeleine. Harvesting is permitted from early April to late December. The fishery is closed in July and August in sub-areas 5A1, 5A2 and 5B1 during the surfclam spawning period. Since 2002, fishermen only have the right to use a single dredger with a maximum width of 2.13 m and spacing between the rods of at least 3.175 cm. A TAC of 113 t was allocated in 2002 to Area 5 and then assigned to sub-area 5A1 in 2005. This TAC was increased to 125 t in 2010. A TAC of 55 t has been in effect in sub-area 5A2 since 2005. Lastly, a TAC of 100 t was allocated to sub-area 5B in 2010 and then transferred to sub-area 5B1 in 2011, with a fishing effort limited to 36 days. In sub-area 5B2, the fishing effort has been limited to 12 days since 2011.

This fishery is still developing and is conducted, in part, on new portions of the beds from one year to another (Figure 2). Since 2009, dredge harvesting has been primarily conducted in the northern sections of sub-areas 5A1 and 5B1.

Sub-area 5A1

Landings of Atlantic surfclam in sub-area 5A1 have varied over the years between 107 and 134 t of live weight (Figure 3 and Table 1). The TAC has been reached or slightly exceeded since 2007. In 2012, landings totalled 134 t.

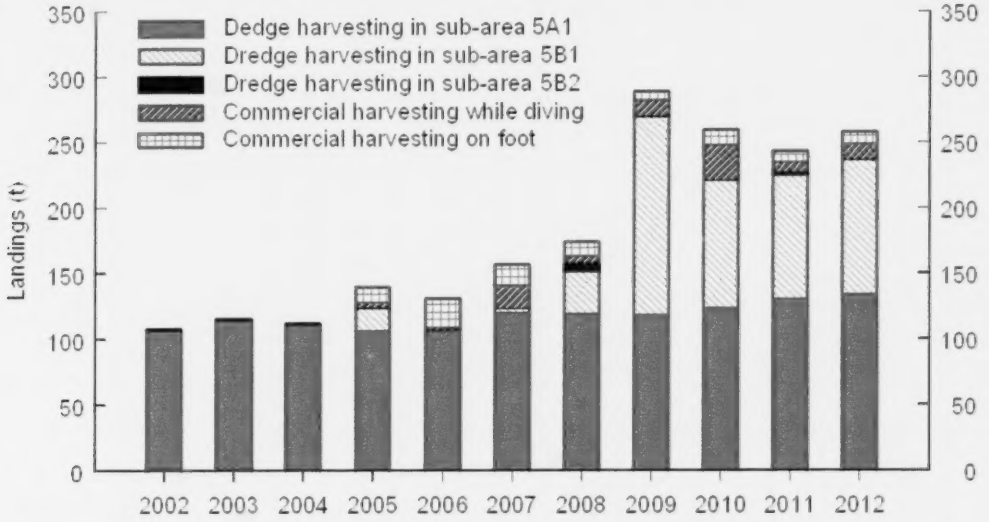

Figure 3. Annual Atlantic surfclam landings (t) per sub-area and type of fishery in the Îles-de-la-Madeleine.

Fishing effort in fishing days was higher (64-65 days) at the beginning of harvesting (Table 1). Since 2008, the effort to reach the TAC has not exceeded 45 days. In 2012, the effort was 21 days, 58% below the mean of the reference period (2002 to 2011).

CPUE have been increasing since 2008, and reached 314 kg/hm in 2012, 100% higher than the mean of the reference period (2002-2011) (Figure 4 and Table 1). This significant increase in CPUE in recent years can be explained by the discovery of new beds.

The size (anteroposterior length of the shell) of surfclams landed may extend from 73 to 164 mm depending on the year, with median sizes between 110 and 128 mm (Table 1). There has been an upward trend in recent years, however; the median size in 2012 was 128 mm.

The size of known beds in sub-area 5A1 is estimated at nearly 24 km^2 based on fishing positions recorded since 2002. The annual proportion of dredged surfclam bed area is 3% on average for the past three years (Table 1).

Table 1. Landings (t), harvesting effort (days), mean catch per unit effort (CPUE in kg/hm), median size (mm) at landing and the proportion of the dredged surfclam bed area (Area, %) from 2002 to 2012 for sub-areas 5A1 and 5B1 of commercial Atlantic surfclam dredge harvesting in the Îles-de-la-Madeleine.

Year	5A1					5B1				
	Landings	Effort	CPUE	Size	Sup.	Landings	Effort	CPUE	Size	Sup.
2002	108	65	138		5.5					
2003	115	64	123		7.0					
2004	112	64	112	110	7.4					
2005	107	31	213	110	3.9					
2006	108	55	140	114	5.6					
2007	121	63	119	124	7.7					
2008	120	42	142	121	6.2	32	13	127	120	8.4
2009	118	45	166	123	5.7	152	51	202	122	27.3
2010	124	36	223	124	3.5	97	28	211	120	16.2
2011	131	36	200	126	3.2	94	27	217	128	12.4
2012	134	21	314	128	2.3	103	20	275	133	10.0
Ref.[1]	116	50	157	119	5.6	94	30	189	122	16.1
Diff.[2]		-58%	100%	8%			-33%	46%	9%	
Avg.[3]	130	31	246	126	3.0	98	25	234	127	12.9

[1] *2002-2011 reference average for sub-area 5A1 and 2008-2011 reference average for sub-area 5B1.*

[2] *Relative difference of the value in 2012 to the reference average.*

[3] *Average for the last three years (2010 to 2012).*

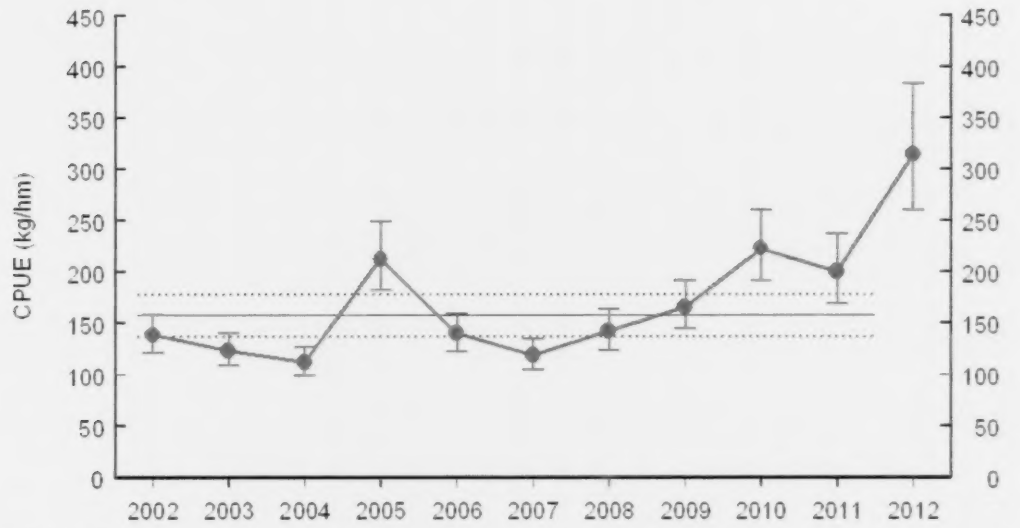

Figure 4. Annual mean catch per unit effort (CPUE ± confidence interval of 95%) for commercial Atlantic surfclam dredge fishery in sub-area 5A1 of the Îles-de-la-Madeleine. The horizontal lines represent the 2002-2011 reference average (solid lines) ± ½ standard deviation (dotted line).

Sub-area 5B1

Prior to 2008, harvesting in sub-area 5B1 was only occasional. However, in 2008, a bed was found north of the Îles-de-la-Madeleine, at the limits between sub-areas 5B1 and 5A1 (Figure 2).

Since 2010, landings from sub-area 5B1 have totalled approximately 100 t (Figure 3 and Table 1), with a harvesting effort of 20 days in 2012 (Table 1). CPUE have been relatively stable since 2009 (Figure 5 and Table 1). In 2012, the CPUE was 275 kg/hm, which was higher than the reference average. In 2011 and 2012, the median size of landed surfclam from sub-area 5B1 was greater than the 2008-2011 reference average (Table 1).

The size of known beds in sub-area 5B1 is estimated at nearly 5 km^2 from fishing positions recorded in logbooks from 2008-2012. The annual proportion of dredged surfclam bed area decreased from 16% in 2010 to 10% in 2012, which was relatively high compared to that observed in 5A1 (Table 1).

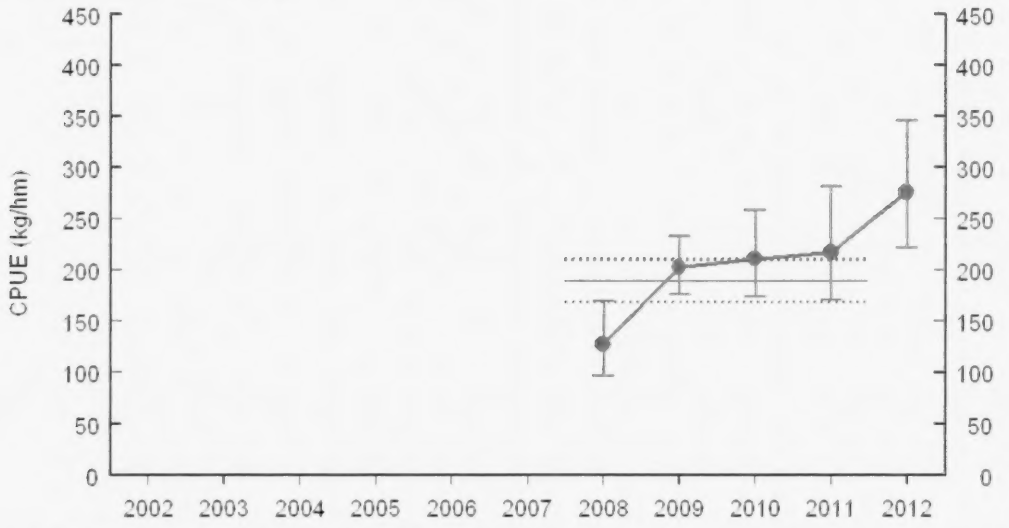

Figure 5. Annual mean catch per unit effort (CPUE ± confidence interval of 95%) for commercial Atlantic surfclam dredge fishery in sub-area 5B1 of the Îles-de-la-Madeleine. The horizontal lines represent the 2008-2011 reference average (solid lines) ± ½ standard deviation (dotted line).

Hand digging

In 2003, new provisions amending the 1985 Atlantic Fisheries Regulations provided a better framework for recreational harvesting of several molluscs, including the Atlantic surfclam, by indicating the species, authorized tool, minimum catch size and daily limit. An initial management plan was established in 2005 to regulate hand digging (hand tools) of Atlantic surfclam in the Îles-de-la-Madeleine. Since then, any hand harvester wishing to harvest more than 300 clams per day or earn an income must obtain a commercial license, regardless of whether harvesting on foot or while diving. Between 121 and 135 licenses have been issued annually since 2005. Commercial or recreational manual harvests are legislated by a harvesting season of nearly 12 months, from mid-January to late December, and by a minimum legal size of 76 mm. Commercial harvesters must keep a logbook.

Manual harvesting of Atlantic surfclams is an activity that has a long history in the Îles-de-la-Madeleine lagoons or near its coast. Harvesting is very popular during the summer. It is

practiced in about 10 shellfish sectors, but more intensively in sectors A-09.5 (mainly islands B and C) and A-09.1, located in the Grande Entrée lagoon, along Dune-du-Sud (A-12.1), at Havre aux Maisons channel (A-16.1.2), at the Camping Gros-Cap (A-16.2.1.1) and along the Plage de La Martinique (A-17.1) (Figure 6). According to a census conducted annually by volunteers and based on information recorded in logbooks, on finer summer days, there may be more than 50 harvesters on the same bed.

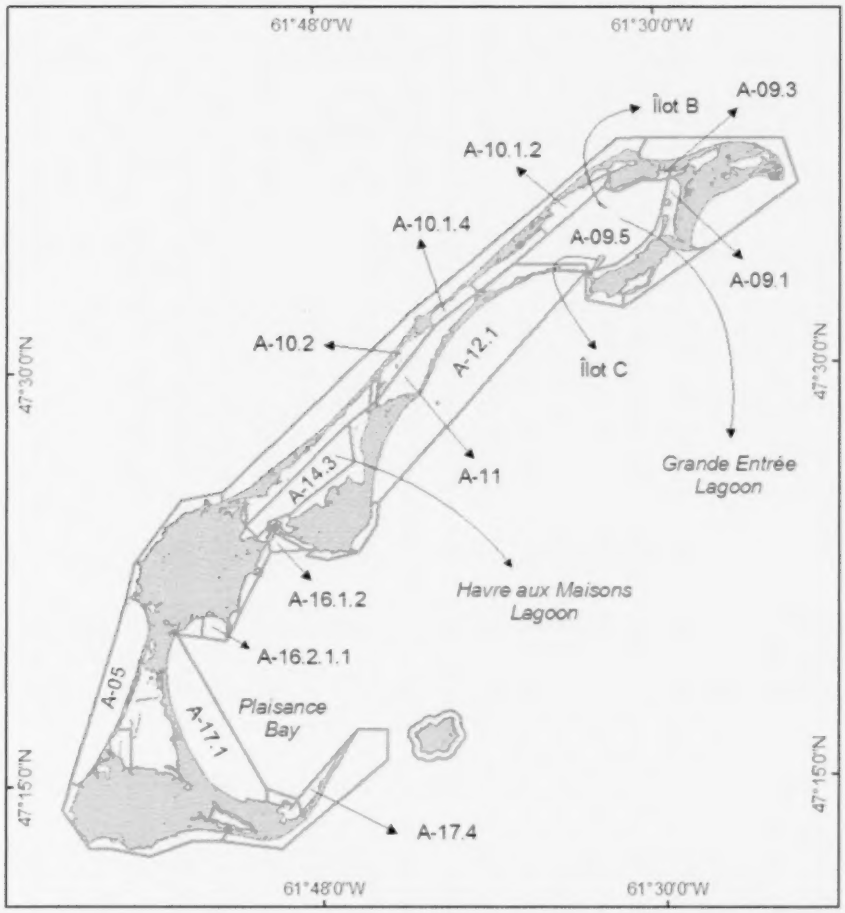

Figure 6. Location of the primary shellfish sectors and of both islands (B and C) in the Grande Entrée lagoon, where Atlantic surfclam is hand harvested in the Îles-de-la-Madeleine.

Despite its popularity, the available information on hand harvesting, whether on foot or while diving, is limited. Between 30 and 60% of active commercial harvesters do not keep logbooks, and there is no information available on landings from manual recreational harvesting. As there is only partial effort data available, it is difficult to accurately assess the status of the different beds harvested by hand digging. The indicators have therefore been calculated for all harvested shellfish sectors using information in the available logbooks.

Since 2005, landings from commercial harvesting while diving have varied from 1.5 to 26.9 t, and those for commercial harvesting on foot have varied from 5.9 to 21.7 t (Table 2 and Figure 3). The mean known landing (2002-2011) for hand harvesting as a whole is 22 t; however, this represents only a small portion of the total amount harvested. The data on manual

surfclam harvesting effort contains the same variations as that for landings; it was calculated at 154 days in 2012 (Table 2).

Table 2. Landings (t), harvesting effort (days), mean catch per unit effort (CPUE in kg/h) and median size (mm) at landing of Atlantic surfclam for commercial harvesting on foot and while diving in the Îles-de-la-Madeleine from 2005 to 2012.

Year	While diving				On foot				Total	
	Landings	Effort	CPUE	Size	Landings	Effort	CPUE	Size	Landings	Effort
2005	3.4	17	38.1	113	11.3	92	27.5	89	14.7	109
2006	1.5	11	51.1	128	21.7	189	29.2	94	23.1	200
2007	17.1	66	55.6	129	15.0	156	27.8	109	32.1	222
2008	5.4	21	62.7	136	10.2	92	29.9	102	15.7	113
2009	12.1	40	59.7	132	5.9	65	26.0	97	18.1	105
2010	26.9	138	41.0	133	10.8	142	19.1	100	37.7	280
2011	7.6	37	38.2	130	8.1	83	21.3	105	15.7	120
2012	11.6	58	36.9	131	8.8	96	17.8	104	20.4	154
Ref. [1]	10.6	47	49.5	129	11.9	117	25.8	99	22.4	164
Diff. [2]			-25%	1%			-31%	4%		
Avg. [3]	15.3	78	38.7	131	9.2	107	19.4	103	24.6	185

[1] *2005-2011 reference average.*
[2] *Relative difference of value in 2012 to the reference average.*
[3] *Average for the last three years (2010 to 2012).*

Since 2010, the mean annual CPUE from commercial harvesting while diving has been below the reference average (2005-2011) of 49.5 kg/h (Table 2 and Figure 7). Since 2006, the median size of landed surfclam from harvesting by diving has been greater than 128 mm (Table 2).

Information from logbooks show that the mean CPUE from commercial harvest on foot were consistently between 26 and 30 kg/h from 2005 to 2009 (Table 2 and Figure 8). However, they have been under 22 kg/h since 2010, which is lower than the reference average. The landed surfclam were the smallest in this fishery, with a median size of 104 mm in 2012. However, the median sizes have been relatively stable since 2007 (Table 2).

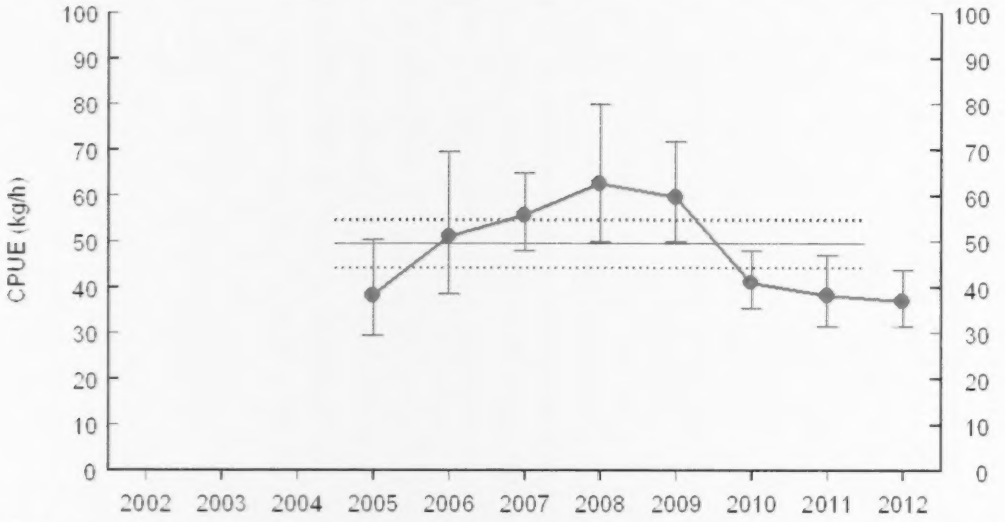

Figure 7. Annual mean catch per unit effort (CPUE ± confidence interval of 95%) for commercial Atlantic surfclam harvesting while diving in the Îles-de-la-Madeleine. The horizontal lines represent the 2005-2011 reference average (solid lines) ± ½ standard deviation (dotted line).

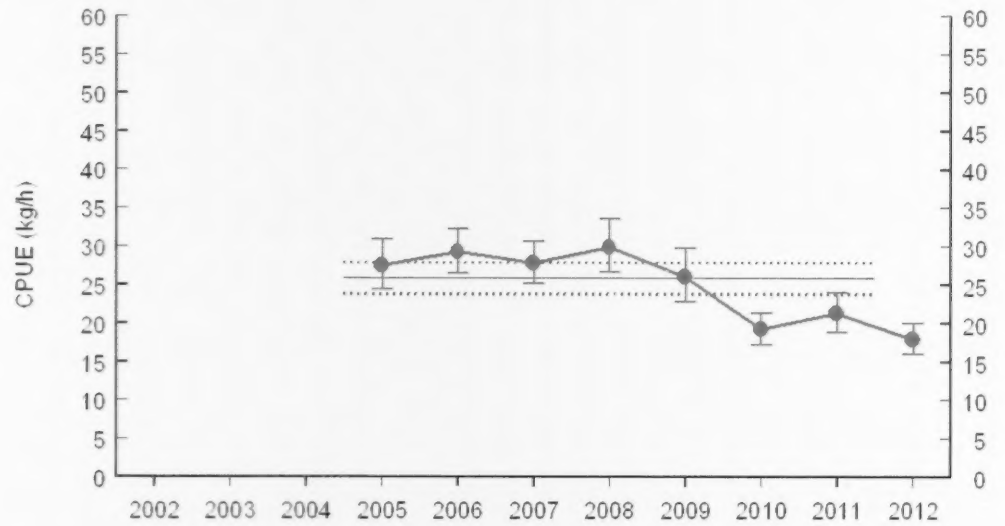

Figure 8. Annual mean catch per unit effort (CPUE ± confidence interval of 95%) for commercial Atlantic surfclam harvesting on foot in the Îles-de-la-Madeleine. The horizontal lines represent the 2005-2011 reference average (solid lines) ± ½ standard deviation (dotted line).

Research surveys

A project carried out as part of the Fisheries Science Collaborative Program (FSCP) aimed to assess the area and density of three beds of Atlantic surfclam heavily harvested on foot, islands B and C in the Grande Entrée lagoon (shellfish sector A-09.5) and one bed in the shellfish sector of the Camping Gros-Cap (A-16.2.1.1), located in Plaisance Bay (Figure 6). The two islands are made from material dredged in 1981. The research surveys done in July and August 2012 aimed at determining the density of Atlantic surfclam every 100 m along the transects.

Island B has been practically submerged for several years now. Samples were taken from a total of 29 stations around island B, 15 of which were located on the bed (Figure 9). A dense eelgrass meadow delineates the surfclam bed. The area of the bed is 0.54 km^2. In 2012, the average density of surfclams (± standard error) was estimated at 0.8 ± 0.5 surfclams/m^2, compared to 4.2 ± 1.0 surfclams/m^2 in 2007. The size of surfclams harvested varied between 33 and 130 mm.

The configuration of island C has changed over the years; it has decreased in length but become wider (Figure 9). Samples were taken from 25 stations, 12 of which were located on the surfclam bed. As is the case with island B, a dense eelgrass meadow delineates the 0.36 km^2 bed. In 2012, the average density of surfclams was estimated at 1.0 ± 0.4 surfclams/m^2, compared to 3.1 ± 0.7 surfclams/m^2 in 2007. The size of the surfclams harvested varied between 9 and 132 mm.

Samples were taken from a total of 27 stations in the Camping Gros-Cap sector, 11 of which were located on the surfclam bed (Figure 9). The size of the bed was 0.26 km^2, with an average density estimated at 0.5 ± 0.3 surfclams/m^2. No surveys have been conducted since. The size of the surfclams harvested varied between 13 and 145 mm.

Sources of uncertainty

The lack of information on hand harvesting as a whole, and particularly recreational hand harvesting, could also affect the conclusions issued for this fishery. Moreover, as the territory is shared by dredge harvesting and hand digging and between commercial and recreational harvesters, it makes it difficult to obtain a comprehensive portrait of the situation.

The lack of an independent indicator from research surveys, whether for harvested beds by dredging or by hand digging, implies that scientific advice on Atlantic surfclam stock status is entirely dependent on the quality of data from the commercial fishery.

There is no dockside monitoring for this species. Commercial landings are estimated based on the number of baskets landed. From 2002 to 2011, the weight used for conversion for dredge harvesting was 54 kg per basket. Since 2009, DFO fishery officers have noted that the baskets landed tend to be fuller, and that the weight used for conversion can lead to under-estimation of the true landings. Upon further verification, a weight of 66 kg per basket was used for conversion from the beginning of the 2012 season. However, fishers find that a weight of 60 kg is more realistic. This situation lends uncertainty to the official landings, and to the commercial yields (CPUE) used to assess the state of the resource.

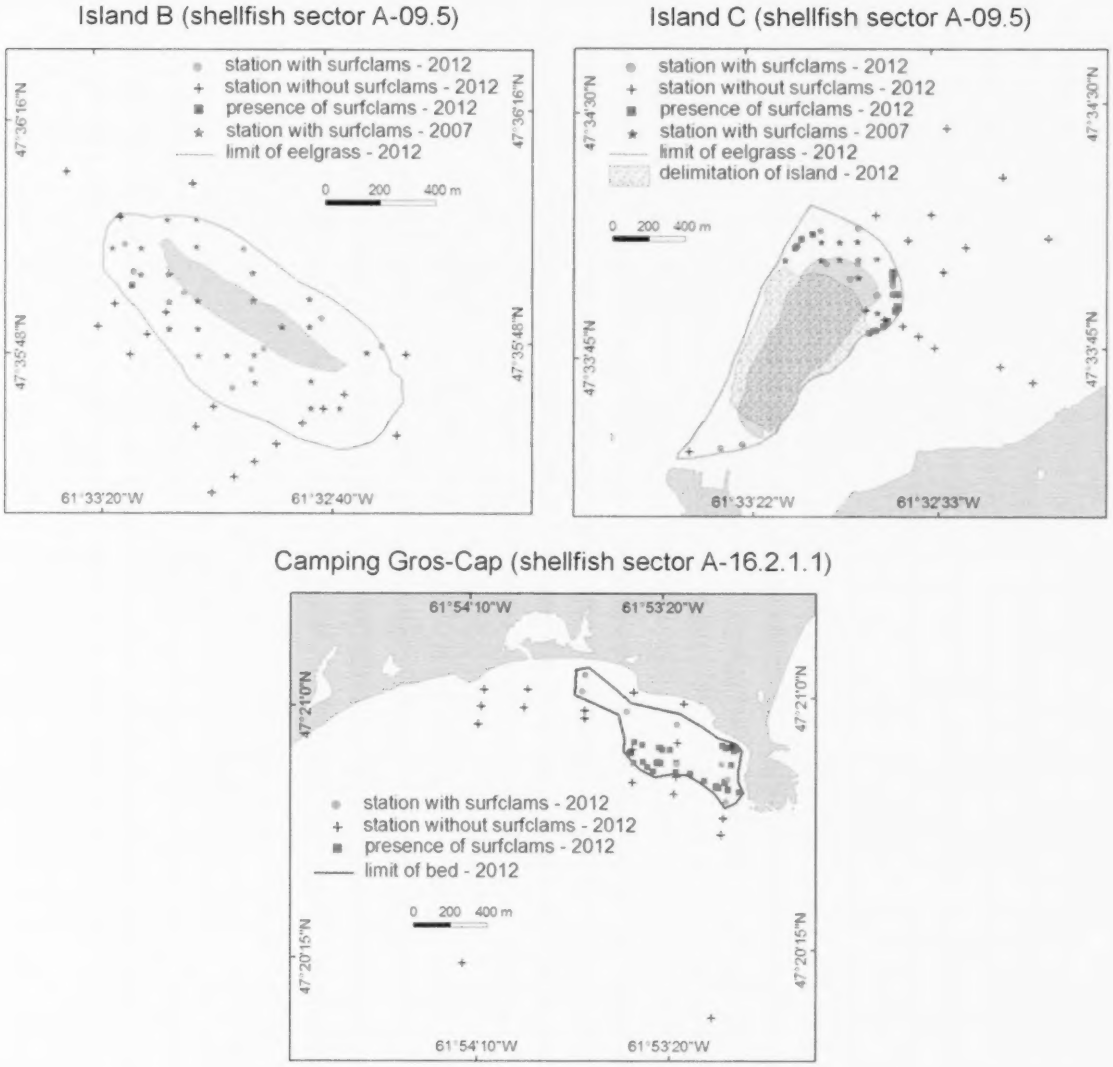

Figure 9. Results of surveys conducted in 2007 and in 2012 and delineation of Atlantic surfclam beds located on islands B and C and at the Camping Gros-Cap in the Îles-de-la-Madeleine.

CONCLUSIONS AND ADVICE

Hydraulic dredge fishery

The hydraulic dredge fishery is still developing in the Îles-de-la-Madeleine and is, in part, conducted on new portions of surfclam beds from one year to another. For the time being, the yields and stability of the size structures can be explained by this displacement of fishing effort. Under such a harvesting pattern, it is difficult to assess the status of the population from commercial indicators, so long as a full harvesting cycle has not been realized.

In this type of situation, it is preferable to be cautious and to apply an increment-based decision rule to adjust quotas. This rule establishes that an increase in quota (or fishing effort) is considered only when it has been reached steadily for three years and that stock status indicators are stable or increasing.

Given that the fishery indicators are positive in 5A1, and that the area of the dredged beds is limited, the TAC could be increased by 10% for 2013. In the event that no new beds are discovered over the next few years, a limit in fishing effort must be associated with an increase in TAC to limit the harvesting of beds that have already been harvested. The annual fishing effort must be restricted to 50 days (average from 2002 to 2011).

Although the various indicators were relatively stable in 5B1, a large proportion of beds are dredged every year. As a result, it is recommended that the current TAC is maintained and that the fishing effort is limited to 30 days (average from 2008 to 2011) for the reasons outlined above.

Hand digging

Although this is a large-scale activity, the information available on hand digging Atlantic surfclam is limited to commercial data (logbooks). Since 2010, the annual CPUE from hand digging on foot or while diving have been under their respective reference averages.

In 2012, surveys of three beds accessible to those digging by hand revealed that nearly all of these beds are accessible on foot. Moreover, the densities of two of these beds were much lower than those observed in 2007, which suggests a high fishing pressure by those hand digging on foot.

Given this information and the lack of knowledge of the contribution of beds accessible on foot to the recruitment to the Atlantic surfclam population in the Îles-de-la-Madeleine, it is recommended that harvesting by hand digging be limited significantly.

OTHER CONSIDERATIONS

The recommended conservation measures are designed to ensure the sustainability of each bed and to allow them to renew themselves. A significant decrease in the density of each bed could compromise the fertilization of ovules and the production of larvae in the Îles-de-la-Madeleine. Any approach aimed at maintaining or even increasing the reproductive potential of each shellfish sector, either by leaving more adults on the bottom or by creating refuge areas, will have a positive impact on resource conservation. The cessation of harvesting during spawning and when juveniles are deposited on the bottom can only be beneficial in protecting the reproductive potential and the recruitment to the population.

Under the circumstances, scientists have proposed various hand harvesting effort reduction measures; however, the scientific value and implementation potential of each of these measures must be assessed. The primary measures proposed are to:

- Increase the minimum legal size to 90 mm or more;
- Lower the daily recreational harvesting limit significantly;
- Establish a refuge area on an extremely dense bed;
- Reduce the manual harvesting season;
- Close certain shellfish sectors temporarily;
- Require that a commercial license be held to harvest surfclam by diving.

Increased monitoring of commercial and recreational manual harvesting of Atlantic surfclam in the Îles-de-la-Madeleine would improve stock status assessment and foster quicker reactions to population changes to prevent the overexploitation of this resource.

SOURCES OF INFORMATION

This Science Advisory Report is from the meeting held on February 7, 2013 for the Assessment of Atlantic surfclam in the coastal waters of the Îles-de-la-Madeleine. Additional publications arising from this meeting will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule.

Cargnelli, L.M., Griesbach, S.J., Packer, D.B. and Weissberger, E. 1999. Essential fish habitat source document: Atlantic surfclam, *Spisula solidissima*, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-142. 13 p.

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